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OBITUARY NOTICES OF FELLOWS DECEASED

BETWEEN 30TH NOV. 1862 AND 30TH NOV. 1863.

ARTHUR CONNELL was the eldest son of Sir John Connell, Judge of the Admiralty Court of Scotland and author of a well-known work on the law of Scotland respecting tithes. He was born in Edinburgh on the 30th of November 1794. Having received his early education at the High School of that city, he (in 1808) entered the University, where he studied under Playfair, Leslie, Dugald Stewart, and Hope. Mr. Connell then became for a time a student in the University of Glasgow, and having there obtained a Snell Exhibition, he went to Balliol College, Oxford, in 1812. In 1817 he passed Advocate at the Scotch Bar, but never practised; following a decided turn for science which had early shown itself, he devoted himself to the pursuit of chemistry, which became his main occupation, and in 1840 he was appointed to the professorship of that science in the University of St. Andrews. In St. Andrews Mr. Connell continued to study and teach his favourite science till 1856, when the fracture of a limb, and its effects upon a constitution already long enfeebled, completely incapacitated him for active duty.

Mr. Connell was chosen a Fellow of this Society at the annual election in 1855; from 1829 he had been a Fellow of the Royal Society of Edinburgh, in whose 'Transactions' or in the 'Edinburgh Philosophical Journal' his various scientific memoirs and communications have appeared. Most of his published researches belong to the province of mineral analysis, in which he justly attained a high reputation for skill and accuracy. To him is due the merit of establishing several new mineral species, and of showing that in certain minerals baryta exists in combination with silicic acid; and as an example of his nicety as an analyst, we may refer to his determination of the constitution of Greenockite from a single grain of that mineral. But Mr. Connell's labours as a chemist were not confined to a single field of inquiry; he was the author of valuable researches on voltaic decompositions, published in the Transactions of the Royal Society of Edinburgh; and he contrived an instrument for ascertaining the dew-point, which is superior in some respects to that generally used.

Mr. Connell died on the 31st of October 1863. He was of a modest, retiring nature and gentle disposition. To those who enjoyed his private friendship, it was well known that the merit he evinced as an earnest and faithful worker in science was but the manifestation, in that special direction, of the excellent qualities which belonged to his natural character.

EDWARD JOSHUA COOPER, one of our most distinguished amateur astronomers, received the first impulses which made him pursue that science from his mother's early teaching, and from his visits to the Armagh Observatory while at the endowed school of that city. Thence he passed to Eton, and from it to Christ Church, Oxford, where it may be feared that in those days he met little encouragement in his favourite pursuit.

After leaving Oxford he travelled extensively, with a sextant, chronometer, and telescope as his inseparable companions. While at Naples in 1820 he met Sir William Drummond, some of whose wild inferences from the Dendera Zodiac he showed to be inconsistent with sound astronomy. Sir William replied that these objections were based on the inaccuracy of the existing drawings; and Mr. Cooper met that by going to Egypt, securing the services of an accomplished Italian artist, and bringing home correct plans of the Dendera ceiling, which, with many other drawings, he printed for private distribution under the title 'Egyptian Scenery.' He thence visited Persia, Turkey, Germany, and Scandinavia as far as the North Cape, accumulating a great mass of observations of latitude and longitude, which unfortunately remain unpublished. Shortly after his return to Ireland the death of his uncle placed him in possession of a large estate, and enabled him to carry out on a great scale the plan which he had formed of determining some portion of the small stars which were in general neglected by the great observatories. In the year 1831 he purchased, from Cauchoix of Paris, an object-glass of 13·3 inches aperture and 25 feet focus, the largest then existing, which in 1834 was mounted with perfect success at his magnificent mansion of Markree, on an equatorial constructed by Mr. Grubb of Dublin. It is of cast iron (the first application of that material to astronomical instruments), and stands in the open air, encircled by the buildings of a first-rate observatory, which contain, among other *chefs-d'œuvres*, a fine meridian-circle by Ertel, with eight microscopes, and an 8-inch object-glass. These instruments were at once applied to active work, in which he had a most able cooperator, his first assistant, Mr. A. Graham; and the Memoirs of the Royal Astronomical Society and of the Royal Irish Academy (of both which he was a member) bear ample testimony of their diligence. One result of their labours was the discovery of the planet Metis; but his greatest work is his 'Catalogue of Ecliptic Stars.' This (which was published by aid from the Government grant placed at the disposal of the Royal Society, and which the Royal Irish Academy honoured with their Cunningham Medal) contains upwards of 60,000 stars down to the 12th magnitude, of which very few had been previously observed. The places are reduced to 1850, and though only approximate, possess a sufficient degree of precision for the use to which they were destined. Their probable error is $\pm 2''\cdot6$, both in right ascension and in declination. The value of this Catalogue to future astronomers can scarcely be overrated, for many facts tend to show that much is to be learned by studying these minute stars. As an instance, it may be stated that fifty stars of his own Catalogue and twenty-seven of others' were found to have disappeared during the progress of the observations. Many of these, no doubt, are variable; many probably are unknown planets; some perhaps have great proper motion. But when shall we have such a survey of the whole sky as that of this comparatively small zone!

He promised a fifth volume, the materials for which are nearly complete,

as is also the case with a set of star-charts, in which, besides all the stars actually observed, as many are inserted as could be interpolated by the eye. It is much to be desired that these should not be lost to astronomy; and all who love that science will express a hope that his representatives will complete a work which has done such honour to their name.

Mr. Cooper continued to observe almost up to his death, which occurred on April 23, 1863, shortly after that of his wife, to whom he was deeply attached. The date of his election into the Royal Society is June 2, 1853. He represented the county of Sligo in Parliament for many years, and was a kind and good landlord, making great exertions to educate and improve his numerous tenantry. His personal qualities were of a high order, blameless and fascinating in private life, a sincere Christian, no mean poet, an accomplished painter and linguist, an exquisite musician, and possessing a wide and varied range of general information.

JOSHUA FIELD was a member of a well-known firm of Civil Engineers at Lambeth. The chief occupation of his life was mechanical engineering, and he had an important share in the improvements which have been made during his time in the construction of marine steam-engines. Mr. Field was one of the founders of the Institution of Civil Engineers, and one of its earliest Vice-Presidents. In 1848 he was elected President, on which occasion he, in his inaugural address, gave a sketch of the progress of improvement in steam navigation. He became a Member of the Royal Society in 1836. His death took place on the 11th of August 1863, at the age of 76.

RICHARD FOWLER, M.D., the oldest Fellow of the Royal Society, died at his residence, Milford, near Salisbury, April 13, 1863, in his 98th year. He was born in London, November 28, 1765, and at an early age was so feeble in health, that it was thought necessary to send him to reside with a relation in Staffordshire. He was thence sent to Edinburgh for his education. While yet a youth he was entered for the medical profession, and while pursuing his studies he eagerly embraced the opportunity of attending the lectures on Moral and Political Philosophy of Dugald Stewart, to whose influence he ever afterwards referred with gratitude. From Edinburgh he proceeded to Paris, at a time when Louis XVI., Marie Antoinette, and the Dauphin were yet to be seen in their regal state; and Dr. Fowler was fond of telling how he saw them thus, and also of having exchanged greetings with Talleyrand while yet the young and courtly Bishop of Autun. He remained long enough in Paris to witness much of the strife of the first French Revolution. He was personally acquainted with Mirabeau, and often listened to his eloquence in the National Assembly. On his return to Edinburgh he was admitted, in Nov. 1790, a Member of the Speculative Society of that city, which had been founded in 1764, and has numbered among its members some of the most eminent

men of Great Britain. Dr. Fowler was an active member, and brought forward questions on politics and social economy for discussion. He early adopted the Liberal side in politics, and that of complete toleration in religion, and throughout his long career he was a steady supporter of Liberal principles. In 1793 he published a work entitled 'Experiments and Observations relative to the influence lately discovered by M. Galvani, and commonly called Animal Electricity.' The work consists of 176 pages, and contains an account of numerous experiments with different metals on frogs, the earthworm, the hearts of cats and rabbits, &c. The work also contains a letter from Professor Robison giving an account of some experiments with dissimilar metals. Dr. Fowler took his medical degree at the University of Edinburgh, Sept. 12, 1793; he was admitted Licentiate of the Royal College of Physicians of London in March 1796, about which time he settled at Salisbury, and was elected Physician to the Infirmary of that city, an office which he filled during forty years; after which he continued to be one of its consulting physicians to the time of his death. In 1802 he was elected a Fellow of the Royal Society. In 1805 he married the daughter of William Bowles, Esq., of Heale House. He had an extensive medical practice during many years, and a still more extensive acquaintance with the leading men of the day, for which he was partly indebted to his early friendship with the Marquis of Lansdowne and Lord Holland, and also to his own social qualities and conversational powers, the latter being enlivened by anecdote, apt quotation, and varied knowledge, which enabled him to say something agreeably and well on almost every subject; at the same time his kindly nature mellowed and improved everything he said and did. In 1831 he became a Member of the British Association, and during a number of years made frequent communications to it on subjects in mental philosophy and their relation to physiology. The last communication was in 1859, when Dr. Fowler, then in his 94th year, made the journey to Aberdeen for the purpose of being present at the Congress. He took great interest in the mental condition of the deaf, dumb, and blind, and was fond of inquiring how it was that persons so afflicted displayed a higher intelligence than that of the most sagacious of the lower animals, and how by touch alone the meaning of others can be communicated to the blind and deaf, and instantly interpreted. During the later years of his life, Dr. Fowler was himself afflicted with loss of sight. Indeed, in his work published in 1793, he complains (page 76) that the weak state of his eyes did not permit him to look intently at minute objects. Nevertheless his mental activity was so great, that when he could no longer see to read he kept employed two men and two boys in reading to him, and writing down from his dictation memoranda for future papers. One of his latest acts, in conjunction with Mrs. Fowler, was to purchase and endow a suitable home for the Salisbury and South Wiltshire Museum, in which he took a great interest, and bestowed on it a large portion of his books and collections. Dr. Fowler was also a

Fellow of the Antiquarian Society, and a member of the Zoological Society, and of the Edinburgh Medical and Speculative Societies.

PETER HARDY (born Dec. 17, 1813, died April 23, 1863) was the son of an officer in the artillery, and the brother of Mr. T. Duffus Hardy of the Record Office and Mr. William Hardy of the Duchy of Lancaster. He was educated for an actuary, was placed in the Equitable Office in 1829, was appointed actuary of the Mutual Assurance Office in 1837, and of the London Assurance Office in 1850. The details of his professional life, active and well employed as it was, offer nothing to record. He distinguished himself in 1839 by the publication of a sound mathematical work on interest, containing tables subdivided into quarter rates per cent. In 1840 he published a system of notation for life contingencies, which, besides its ingenuity, was of a practicable character. In 1848 he was one of the founders of the Institute of Actuaries. He was elected Fellow of the Royal Society in 1839, immediately after the publication of his first work. Mr. Peter Hardy possessed that talent for research which has contributed to render both his brothers eminent in their several walks of life. His walk, indeed, did not offer any opportunities; but the taste found vent in the collection of old books and the study of early printing. In this he would have been eminent, had it been anything but an employment of leisure. His library, very large for that of an actuary, contained rare specimens, of which he knew the history and the literary value.

JOHN TAYLOR was born at Norwich, on the 22nd of August 1779, and died in London on the 5th of April 1863. He was the eldest of five brothers belonging to a well-known and respected family in his native city. In early youth Mr. Taylor showed a natural turn for mechanical contrivance, and a decided bent towards the profession of an engineer; but as his native district afforded but little scope for engineering work, he was brought up to land-surveying, as the employment within reach which seemed to fall in most nearly with his natural taste. From this occupation, however, he was called off at the early age of nineteen, to take the management of the Wheal Friendship Mine in Cornwall. Inexperienced as he then was in all that specially concerned mining work, he was, nevertheless, appointed to that charge, in reliance on his ability to master the task he was to undertake, and on his diligence and integrity in the performance of it.

Soon after he became thus engaged, Mr. Taylor published, in the 'Philosophical Magazine' (for 1800), an article "On the History of Mining in Devon and Cornwall;" and in succeeding years he communicated to the world, in that and other journals, the results of his experience concerning the operations and processes followed in mining, and the means of improving them, and on the general economy of mines.

But whilst his daily occupation was in directing practical work, it was Mr. Taylor's constant aim to elevate the art of mining and place it on a

scientific basis. With this purpose he (in 1829) undertook the editorship, and, to a considerable extent, the cost of a publication which he hoped would conduce to the end in view. This work, which was entitled 'Records of Mining,' did not meet with the support he had looked for, and was not continued; but the part published contains four contributions from his own pen. One of these, which deserves especial notice, is an excellent and well-digested paper, in which he advocates the establishment of a School of Mines in Cornwall, and presents a "Prospectus," setting forth the details of a plan for the foundation, government, and maintenance of an institution of that kind, and for regulation of the instruction it should afford. This proposal did not meet with encouragement at the time, but the establishment of the present School of Mines, although he had no active share in it, may be traced to Mr. Taylor's earnest and judicious representations.

In 1812 Mr. Taylor settled in London, and engaged with his brother in a chemical manufactory at Stratford in Essex; but although he had long applied himself to chemistry as a scientific pursuit, and attained a high reputation as a metallurgic chemist, he was compelled to relinquish it as a profession in consequence of the increased extent and importance of his mining business.

Throughout his eminently practical life Mr. Taylor strove constantly to maintain a healthy reciprocity between science and practice; and while availing himself of his scientific knowledge for the improvement of technical processes, he was no less earnest in turning to account his experience and opportunities as a mining engineer and metallurgist for the promotion of the sciences of geology, mineralogy, and chemistry. We accordingly find his name enrolled as a member of various scientific bodies, both British and Foreign. He was one of the earliest Fellows of the Geological Society, and from 1816 to 1844 filled the office of its Treasurer. In 1825 he was elected a Fellow of the Royal Society, and repeatedly served on the Council. But of the several Societies to which he belonged, the British Association for the Advancement of Science has been the most indebted to Mr. Taylor's useful cooperation, both scientific and administrative. He was, indeed, present at its birth, and the first meeting of its first Council was held at his house. This was on the 26th of June 1832. He was also the first Treasurer, and held that office till September 1861, when the infirmities of age constrained him to retire from it. On relieving him from the duties he had so long and so well discharged, the Council of the Association joined in a unanimous expression of respect for his character and gratitude for his long and valuable services to the cause of science. The Council of University College, London, expressed themselves in no less respectful and grateful terms when, for the same reason, he retired from the Treasurership of that Institution, which he had held for many years.

WILLIAM TOOKE was born on the 22nd of November 1777, at St. Peters-

burg, where his father was then Chaplain to the factory of the Russian Company. Mr. Tooke was a solicitor by profession, but amidst the calls of business he was able to devote much time and attention to public affairs, and took part in the formation of various public institutions which were established during the active period of his life. He was long a leading member and Vice-President of the Society of Arts, and was elected President on the vacancy caused by the death of His Royal Highness the Prince Consort. His election to the Royal Society was in 1818. From 1832 to 1837 he sat in Parliament for the borough of Truro. Besides a compilation on French history, in two volumes, which appeared in 1855, and occasional contributions to magazines, Mr. Tooke, when a young man, published, anonymously, an edition of Churchill's Poems, with notes and a Life of the Author, which was favourably reviewed by Southey. He died in London on the 20th September 1863.

Rear-Admiral JOHN WASHINGTON was born on the 1st of January 1801. He entered the Navy in 1812, on board the 'Juno,' fitting for the American station, where he served for the next two years, and took part in various active and successful operations against the enemy. In 1814 he returned to England, and entered the Royal Naval College at Portsmouth. During the two years he spent as a student in that Institution he applied himself diligently to the scientific study of his profession, and laid the foundation of that skill and accomplishment which he afterwards attained in nautical surveying and hydrography, and through which in the after course of his life he was able to render much valuable service to the maritime interests of this and other countries.

After serving at sea for some years, and rising to the rank of Commander, he returned home for a time, but in 1841 he was appointed to continue the Survey of the North Sea, in which duty he was employed until the close of 1844. In 1842 he was promoted to the rank of Post Captain.

This Survey was Captain Washington's last service afloat; but his experience and judgment were turned to public account at different times, when he acted as a Royal Commissioner on important questions affecting the interests of navigation and of our maritime industry. In 1853 he visited some of the Russian fortresses in the Baltic, and the results of his observations proved of the greatest value in the conduct of the warlike operations which soon followed.

On the retirement of Sir Francis Beaufort, Captain Washington was appointed Hydrographer to the Admiralty, and was promoted to the rank of Rear-Admiral in 1862. His anxious and unremitting application to the various duties of his office is believed by his friends to have shortened his valuable life, which was closed at Frascati, near Havre, on the 16th of September 1863. He was a member of various learned Societies at home and abroad, and was Secretary of the Royal Geographical Society from

1835 to 1841. His election into the Royal Society is dated February 13, 1845.

CÉSAR MANSUÈTE DESPRETZ was born at Lessines in Belgium, on the 13th of May 1789. At an early age he came to Paris for the purpose of devoting himself to the study of chemistry and physics. His intelligence and industry soon attracted the attention of Gay-Lussac, who appointed him répétiteur of his course of lectures on Chemistry at the École Polytechnique. He became the Professor of Physics at the Sorbonne in 1837, having previously held a similar office in the École Polytechnique and the Collège Henri IV. In 1822 the Academy awarded him the prize for the best memoir on the causes of animal heat. In 1825 he published an elementary treatise on Physics, which in 1836 reached a fourth edition; and in 1830 the Elements of Theoretical and Practical Chemistry. He was the author of numerous memoirs published in the 'Annales de Chimie' and in the 'Comptes Rendus,' dating from 1817 up to 1858. These memoirs give an account of researches on the specific heat and conductivity of metals and various mineral substances; on the propagation of heat in liquids; on the transmission of heat from one solid body to another; on the heat absorbed in fusion; on the elastic force of vapours; on the density and latent heat of vapours; on the compressibility of liquids; on the density of gas under different pressures; on the displacement and oscillations of the freezing-point of the mercurial thermometer; on the heat developed during combustion; on the expansion of water, and the temperature at which water and saline solutions attain a maximum density; on the modifications which metals undergo under the joint action of heat and ammoniacal gas; on the chemical action of voltaic electricity, the light and heat of the voltaic arc, and the intensity of the voltaic current; on the electricity developed by muscular contraction; on chloride of boron; on the decomposition of water, carbonic acid, and acetic acid; on the decomposition of salts of lead; on the limits of high and low musical notes; on the fusion and volatilization of some refractory substances under the triple action of the voltaic battery, the sun, and the oxyhydrogen blowpipe.

Though not successful in making any brilliant theoretical discoveries, the important scientific facts he has observed and arranged bring his name perpetually before the reader of any modern treatise on Physics. He laboured hard to fulfil to the utmost his duties as a Professor at the Sorbonne; and his lectures, being carefully prepared and well illustrated by experiments, attracted a numerous auditory. He was elected a Foreign Member of this Society in 1862.

His character was upright and benevolent, his tastes simple, and his habits regular in the extreme. It was his custom every year to make a long excursion in England, Germany, or Italy, by himself, and without letting any one know the day of his departure from Paris.

His last illness was preceded by several slight attacks of cerebral con-

gestion. These were followed by congestion of the lungs, of which he died on the 15th of March 1863.

EILHARDT MITSCHERLICH was born on the 7th of January 1794, in the village of Jever in Oldenburg. His father was pastor of Neuende; his uncle, the well-known philologist, was Professor in Göttingen. He was educated at the Gymnasium of Jever, under the historian Schlosser. Following the example of his uncle, and encouraged by Schlosser, he devoted himself to the study of history, philology, and especially the Persian language. In order to prosecute these studies, he went in 1811 to the University of Heidelberg, and in 1813 to Paris. He had hoped to be allowed to accompany an embassy to Persia, but was prevented by the fall of Napoleon. In 1814, on his return to Germany, he commenced writing a history of the Ghurides and Kara-Chitayens, compiled from manuscripts in the Göttingen Library, and of which a specimen was published in 1815 under the title "*Mirchondi historia Thaheridarum.*" Unwilling to renounce his favourite project of travelling in Persia, he determined to accomplish it without any extraneous assistance. The only way in which it appeared possible to travel was in the character of a physician; accordingly he resolved to study medicine. He went to Göttingen for this purpose, and first applied himself to the introductory sciences, especially to chemistry, which so fascinated him that he gave up philology and his intention to visit Persia. In 1818 he went to Berlin for the purpose of obtaining license to lecture. Link allowed him to carry on his researches in the laboratory of the University. Here he undertook the examination of the phosphates and arseniates, and confirmed the accuracy of the latest conclusion arrived at by Berzelius, viz. that phosphoric and arsenic acid contain each five equivalents of oxygen, while phosphorous and arsenious acid contain three equivalents. He noticed at the same time that the similarly constituted phosphates and arseniates crystallized in similar forms. Up to this period he had never paid any especial attention to crystallography, but the conviction that he was on the eve of a great discovery allowed him no rest; he studied the laws of crystallography, learned the method of measuring the angles of crystals, and soon satisfied himself that the phosphates and arseniates are not merely similar but identical in form, and that, consequently, bodies exist of dissimilar composition having the same crystalline form, and that these bodies are compounds containing respectively the same number of equivalents. Many minerals appeared to confirm this law, viz. the carbonates, dolomite, chalybite, diallogite and calcite, and the sulphates, baryte, celestine, and Anglesite. In confirmation, however, of this discovery he considered it necessary to appeal to artificial salts which crystallize readily and distinctly, and are easily obtained of sufficient purity, so that his conclusions might be confirmed by any one without difficulty. The neutral sulphates of protoxide of iron, oxide of copper, oxide of zinc, and magnesia, which all con-

tain water, mostly in different proportions, appeared peculiarly well fitted for this purpose. He found that the following were similar in form :— (1) sulphate of copper and sulphate of protoxide of manganese ; (2) sulphate of protoxide of iron and sulphate of oxide of cobalt ; (3) sulphate of magnesia, sulphate of oxide of zinc, and sulphate of oxide of nickel. He also found that the salts which had dissimilar forms contained a different number of equivalents of water, and that those which had similar forms contained the same number. He then mixed the solutions of the different sulphates, and found that the resulting crystals had the form and the same number of equivalents of water as some one of the unmixed sulphates. Lastly, he examined the combinations of these sulphates with sulphate of potash, and showed that the double salts had all similar forms belonging to the oblique system, and that they were composed of one equivalent of the earthy or metallic sulphate, one equivalent of sulphate of potash, and six equivalents of water. The memoir in which these observations are recorded was presented to the Berlin Academy on the 9th of December 1819. In the course of the preceding August Berzelius came to Berlin, on his way from Paris to Stockholm. He became acquainted with Mitscherlich, and conceived such an opinion of his talents, that he suggested him to the Minister Altenstein as the most fitting successor to Klaproth in the chair of Chemistry in the University of Berlin. Altenstein did not at the moment act upon this suggestion, but consented to the proposal that Mitscherlich should perfect his chemical education by working for some time under the guidance of Berzelius. In Stockholm he continued and extended his researches on the phosphates and arseniates, and wrote a memoir on the subject, which appeared in the Transactions of the Swedish Academy. In it he described with great care the forms of the acid and neutral phosphates and arseniates of potash, soda, and ammonia, the neutral double salts of potash and soda, and of ammonia and soda, and the phosphates and arseniates of oxide of lead. He showed in every case that the phosphates and arseniates have similar forms and analogous compositions. Urged by Berzelius to give a name to this newly detected property of the chemical elements, he designated it by the term *isomorphism*. This discovery was of the highest importance to the theory of chemical equivalents, inasmuch as it explained the exceptions to the law of definite proportions in the mineral system of Berzelius. It appeared moreover, from the crystallization of the mixtures of the different sulphates, that isomorphous substances combine in all proportions ; and that they replace one another in indefinite proportions in the composition of minerals was proved by Mitscherlich's fellow-students, Heinrich Rose and Bonsdorff, in the cases of augite and amphibole.

The doctrine of isomorphism, moreover, was an admirable test of the determination of the equivalents of the different elements, whilst the smallness of the number of changes in the equivalents of the simple substances that followed the discovery of isomorphism, is an indication of the

admirable sagacity with which they had been determined by Berzelius. Mineralogists and chemists had long been occupied with researches on the relation between chemical composition and crystalline form; they had discovered a number of important facts bearing upon the subject, but no one had discovered the basis upon which the phenomena rested. Fuchs had already observed that some of the constituents of a mineral might be replaced by others without any change of form, and had called these constituents *vicarious*, but by adducing the sesquioxide of iron and lime as vicarious constituents in Gehlenite, he showed that the true explanation had eluded his grasp. Fuchs had moreover remarked the close resemblance of the mineral sulphates to one another, as well as that of the rhombohedral carbonates. He also showed that strontianite was not rhombohedral as Haüy supposed, but prismatic, and that it resembled Aragonite in form. The small percentage of strontian detected in Aragonite by Stromeyer was regarded by Fuchs as the cause of the resemblance of the forms of the two minerals, as the very small quantity of carbonate of lime in chalybite had been supposed the cause of its resemblance to calcite. The only conclusion which Fuchs drew from the resemblances of these minerals was, that certain substances possess such an overpowering force of crystallization, that, even when present in small quantity, they constrain other substances to assume their form.

In November 1821 Mitscherlich returned to Berlin, was elected a Member of the Academy of Sciences and appointed Professor extraordinary in the University, and remained in that position till 1825, when he became Professor in ordinary. In the summer of 1822 he gave his first lecture on Chemistry to a large audience. He also continued his researches on isomorphism, and those which he had commenced in Stockholm, especially those which bore upon the artificial formation of minerals. He exhibited to the Academy a collection of about forty crystallized substances, which he had found in the slag-heaps surrounding the copper-smelting furnaces of Fahlun during a visit he paid to that place in 1820, in the company of Berzelius. Of these, however, he described only two, a silicate of protoxide of iron isomorphous with olivine, and a mica, the composition of which approximates closely to that of a black mica of Siberia. He resumed these researches along with Berthier in the winter of 1823 and 1824, which he passed in Paris, and by fusing the mineral constituents together in proper proportions, succeeded in producing diopside, idocrase, and garnet.

In the course of his examination of the phosphates and arseniates he had observed that the acid phosphate of soda crystallizes in two totally different forms, both of which belong to the prismatic system, but cannot be referred to the same parameters. From this he inferred that the ultimate atoms of crystallized bodies by change of circumstances may admit of a change in their arrangement, and hazarded the opinion that, as Aragonite resembles strontianite and cerussite in form, and calcite re-

sembles dolomite, chalybite, and diallogite, it is possible for the substances isomorphous with Aragonite to crystallize in the form of calcite, and the substances isomorphous with calcite to crystallize in the form of Aragonite, and so greatly enlarge each group of isomorphous bodies. This opinion was looked upon with great distrust by chemists and mineralogists. All the examples he had brought forward were taken from compound bodies, which possibly might have contained admixtures which analysis had failed to detect, and the substances assumed to have the same composition might after all be different. These doubts were suggested by the analyses of Aragonite, which had been pronounced by some of the most eminent chemists of the time to be pure carbonate of lime; then Stromeyer detected strontia in it, which, notwithstanding that its amount was very small, and different in Aragonite from different localities, was immediately regarded as the cause of the difference of its form from that of calcite; lastly, Buchholtz proved the existence of a variety of Aragonite absolutely free from any admixture of strontia, to which, therefore, the difference of form could not by any possibility be due. At this conjuncture Mitscherlich made the remarkable discovery that sulphur also takes different forms under different circumstances. The crystals obtained from solutions belong to the prismatic system, and are identical in form with those which occur in nature; but when sulphur is fused and allowed to cool, with proper management distinct crystals are obtained, but they are entirely different from the former, inasmuch as they belong to the oblique system. This observation was of great importance, because sulphur being a simple substance crystallizable at pleasure in either of its two forms, the difference of form could not be attributed to a difference of composition. He had already proved that the acid phosphate of soda and carbonate of lime possessed the same property of crystallization in two different forms, which he now considered as appertaining to all simple substances and their chemical combinations, and to which he gave the name of *dimorphism*. He regarded it, moreover, as affording an explanation of the fact that bodies possessing analogous chemical constitutions are not always isomorphous. The memoir on the dimorphism of sulphur was presented to the Academy on the 26th of July 1826.

It was found that the forms of isomorphous substances are not absolutely identical, except, of course, when they belong to the cubic system, but exhibit some differences, showing that the chemical nature of the substance is not altogether without influence on the form. In order to determine the difference between the angles of isomorphous bodies with greater accuracy than was attainable by the use of the ordinary Wollaston's goniometer, he caused a goniometer to be constructed by Pistor, provided with four verniers, each reading to 10'', and with a telescope magnifying twenty times for viewing the reflexions of the signal in the faces of the crystal. With this instrument, in the summer of 1823 he began to measure the angles of calcite from Iceland, and was surprised to find differences in the

angle between the same pair of cleavages amounting to $20''$, a difference which, though small, was too large to be attributed to errors of pointing or reading. The observations were made in the morning and in the afternoon in a room facing the south. The morning observations differed from those made in the afternoon, but the observations made at the same period of the day agreed well with one another; also the temperature of the room in the afternoon was nearly 4° C. higher than in the morning. He therefore concluded that the variation of the angle could only be due to the unequal expansion of the crystal in different directions. He increased the difference of temperature by immersing the crystal in a bath of heated mercury, and found that the cleavages became more nearly at right angles to one another, by $8' 34''$, for an increase of temperature of 100° C. In dolomite from Traversella, Breunnerite from Pfäfers, chalybite from Ehrenfriedersdorff similar changes occurred amounting to $4' 6''$, $3' 29''$, and $2' 22''$ respectively, for a change of temperature of 100° C. A large number of other crystals examined by him afforded like results. In the winter of 1823–1824, during his stay in Paris, he measured the expansion of calcite in volume by Dulong's method, and found it equal to 0.001961 for 100° C. Hence it appears that by an increase of temperature of 100° C. the crystal expands 0.00288 in the direction of its axis, and contracts 0.00056 in a direction at right angles to its axis. He confirmed the accuracy of this most unexpected result by comparing, at different temperatures, the thicknesses of two plates of calcite of nearly equal thickness, bounded by planes parallel and at right angles to the axis respectively, and the thickness of a plate bounded by planes parallel to the axis with that of a plate of glass of nearly the same thickness, the expansion of which was known. His memoir on this important discovery was presented to the Academy on the 10th of March 1825.

The large goniometer which he employed in these observations being too cumbersome, and also too costly to be used by mineralogists in measuring the angles of crystals, he contrived an instrument more convenient for ordinary use, reading to half a minute, and provided with a telescope having a magnifying power of not more than three. The signal consists of cross wires in the focus of a collimator, as in the goniometers of Rudberg and Babinet. The adjustment of the crystal is effected by a very ingenious contrivance due to M. Oertling, by whom many of these instruments have been constructed. By the invention of this goniometer, which has come into general use under the name of Mitscherlich's goniometer, he conferred a great boon on mineralogists. A minute description of it appeared in the *Memoirs of the Berlin Academy* for 1843, a considerable time after it was originally contrived, and not till its value had been tested by long use.

Of his observations on the effect of heat on the double refraction of crystals, little is known beyond a notice in Poggendorff's '*Annalen*' of the remarkable changes which occur in gypsum when heated. At the ordinary temperature of the atmosphere the optic axes lie in a plane at right angles

to the plane of symmetry, and make angles of about 60° with a normal to the plane of symmetry. On warming the crystal the optic axes approach the plane of symmetry, and at about 92° C. they coincide, exhibiting the phenomena of a uniaxial crystal, and on further increasing the temperature they open out in the plane of symmetry.

In 1827 Mitscherlich discovered selenic acid, and the isomorphism of seleniate of potash with sulphate of potash, and afterwards of other seleniates with the corresponding sulphates. In 1830 he observed the isomorphism of manganate of potash with sulphate of potash. This led him to a further examination of manganese, and to the discovery of the isomorphism of the permanganates with the perchlorates, and to the isolation of the hydrate of permanganic acid. At a later period (1860) he repeated, by new and more accurate methods, the analysis of permanganate of potash, which had been called in question, confirming the exactness of the earlier analysis; he succeeded at the same time in isolating the anhydrous permanganic acid.

The crystallographic researches he carried on about the time of the discovery of the new acids were extremely numerous, yet very little has been made known respecting them. He prepared a large number of salts in his laboratory, determined the systems to which they belonged, measured some of the angles, and drew by hand the figures of their principal combinations. But this, though it satisfied his own curiosity, was manifestly insufficient for publication, and the new discoveries that presented themselves were much more attractive than the wearisome and time-consuming task of preparing his researches for the press. He made, however, an attempt to carry out his intention of describing the forms of the most important simple and compound bodies. He commenced with the sulphates, seleniates, and chromates, because these salts present almost all the phenomena on which the laws of crystalline form and chemical composition are founded. He described the sulphates and seleniates of soda and of oxide of silver; the sulphate, seleniate, and chromate of oxide of silver and ammonia; the sulphate and seleniate of oxide of nickel, and the seleniate of oxide of zinc; the anhydrous and hydrous chloride of sodium; iodide of sodium and bromide of sodium; sulphate, seleniate, and chromate of potash, and sulphate of ammonia. Unfortunately these were his last regular contributions to crystallographic chemistry. Long afterwards he described the forms of the chloride and iodide of mercury, the latter of which is dimorphous, and the forms of phosphorus, iodine, and selenium crystallized from solution in bisulphide of carbon, which proved to be in an isomeric state differing in density from fused selenium.

In 1833 his crystallographic labours were interrupted by the publication of his 'Treatise on Chemistry.' For this work he had been long preparing himself by original researches, by associating with the most eminent chemists of Europe, by visiting their laboratories, and the most important chemical manufactures and smelting-furnaces. A large number of original

observations of his own are embodied in this work, which had never appeared in any scientific journal. A fifth edition was commenced in 1855, but left unfinished. In this year he commenced his important labours on the density of the vapour of bromine, sulphur, phosphorus, arsenic, and mercury, nitrous acid, nitric acid, sulphuric acid, &c., and on the relation of the density of vapours to their chemical equivalents. In the same year he commenced his researches on benzoyl, which suggested to him a simple theory of the constitution of those organic combinations in which compound radicals are assumed to exist. His experiments on the formation of ether led him to the doctrine of chemical combinations and decompositions by contact, whereby dormant affinities in mixtures, or compounds held together by feeble affinities, become active by mere contact with a substance chemically inactive. These labours in the domain of organic chemistry wholly occupied him for nearly twelve years. At the conclusion of this period he turned his attention to geology. Indeed, ever since he had engaged in researches on the artificial production of minerals, he used to theorize on the formation of rocks, and on the existence of mineral springs and volcanos. In his earlier travels, while his main object was the examination of chemical manufactures and smelting-furnaces, his attention was also directed to the geology of the countries through which he passed. He frequently devoted the concluding lectures of each half-year's course to a sketch of the geological structure of the earth, and the changes which its surface had undergone. Year after year he made systematic journeys in the Eifel, with the intention of publishing a complete description of the extinct volcanos of that district, and connecting it with a theory of volcanic action. And, as the study of this region made a comparison with the volcanos of other countries desirable, he visited in succession the principal volcanic districts of Italy, France, and Germany. But, notwithstanding all this preparation, the description of the Eifel was never printed, with the exception of some pages distributed among the hearers of lectures of a popular character given by him in the winter of 1838 and 1839. In these he states the views of the nature of volcanic processes which he then entertained. They appear to have been founded on a very careful study of volcanic phenomena. He supposes the explosive action to be caused by the vapour of water. The only hypothesis, however, by which the presence of water in an active volcano could at that time be accounted for, was beset by serious difficulties. These have since been removed by the beautiful experiment made by Daubrée, which shows that when one side of a stratum of porous rock is heated, water in contact with the opposite side makes its way through it, in the direction of the heated part, notwithstanding the high pressure of the vapour generated on that side.

During the autumnal vacation of 1861 he made his last geological excursion in the Eifel; in December of that year he began to suffer from disease of the heart, the complaint increased in severity in the summer of

1862, and he had much difficulty in completing his course of lectures. In the autumn of this year he went again to the Rhine, but only to stay in a country-house near Bonn, the home of his son-in-law, Professor Busch. Here his health appeared to revive, and he returned to Berlin feeling so much better that he commenced his winter lectures; a fortnight before Christmas, however, he was obliged to give them up, never again to be resumed. In the spring of 1863 he retired to a country-house at Schöneberg, near Berlin, and here, on the morning of the 28th of August, his valuable life was closed by a painless death. His name will ever be cherished in the annals of that science which he had so greatly enriched. Few philosophers have ever united such a versatility of genius with a mind so severely disciplined, or who, possessing such a talent for observing, were able to deduce such important results from their observations.

He was member of probably every Academy in Europe. He was elected Foreign Member of the Royal Society in 1828; the Royal Medal was awarded to him in 1829, "for his Discoveries relating to the Laws of Crystallization, and the Properties of Crystals."

In 1852 he was elected Foreign Associate of the French Institute, in the place of CErsted.

The greater part of the preceding notice is extracted from an Address to the German Geological Society by Professor G. Rose, Mitscherlich's successor as President of the Society.

CARL LUDWIG CHRISTIAN RÜMKER was born on the 28th of May 1788, at Neubrandenburg in Mecklenburg-Strelitz, in the service of which State his father held an important position. After a careful preparatory education at home, he was sent to the Graue Kloster at Berlin, and later to the Engineering Academy of that place. In 1807 he passed the Government examination for qualification as an engineer and architect.

In consequence of the gloomy aspect of affairs in Prussia after the peace of Tilsit, he endeavoured to establish himself in Hamburg; but here also, finding no prospect of occupation in the profession he had adopted, he resolved in 1808 to go to England with the intention of devoting himself to a seafaring life. Accordingly, in the 21st year of his age, he began the world anew, under the most unfavourable circumstances, in a strange country, without friends, and entirely cut off from his home by the continental blockade. With an energy and strength of character peculiarly his own, he overcame the difficulties of his situation, and obtained an appointment as Midshipman in the Navy of the East India Company. Feeling dissatisfied with this service, he entered into that of the German house of Rücken in London, and visited many parts of the world in their ships. In 1811 or 1812 he obtained admission into the Royal Navy, and served during the latter part of the war on board various ships of the Mediterranean fleet. He was first appointed to the 'Benbow'; afterwards he became Naval Instructor on board the 'Montague,' Captain Peter Heywood (formerly of the

‘Bounty’), of whom he used to speak in terms of the greatest regard, as the most kind-hearted and excellent man he had ever known. He was then transferred to the ‘Albion,’ and on his passage out from England to join Sir Charles Penrose, fought at the battle of Algiers.

During a visit to Genoa Rümker became acquainted with the Baron v. Zach, to whom he submitted the results of various astronomical observations in order to obtain his opinion of their value. The Baron soon discovered his talent for astronomy, encouraged him to cultivate that science, and aided him with his advice and the use of his astronomical library. Rümker’s first observations, occultations, and the determination of the latitude and longitude of Malta, where he was stationed for a considerable time, were published in v. Zach’s ‘Correspondance Astronomique.’

In 1817, when the Fleet returned to England, he quitted the Naval Service and went to Hamburg, carrying with him the friendship and esteem of his comrades of all ranks, which he had won by his ability and energy, combined with a peculiar suavity of manner. Here he was appointed Principal of the School of Navigation. In the society of Schumacher, the Director of the Observatory of Altona, Repsold, and Woltmann, his taste for astronomy was strengthened, and he found many opportunities of extending his knowledge of the subject. As at that time Hamburg did not possess an Observatory, he built one at his own expense on the Stintfang.

In 1821 he resigned his post at the School of Navigation in order to accompany Sir Thomas Brisbane, Governor of New South Wales, to whom he had been introduced by Captain Heywood, and to take charge of the Observatory which Sir Thomas purposed founding in that colony.

Rümker’s labours in the Observatory of Paramatta are well known to astronomers. In 1822 he observed the first calculated reappearance of Encke’s comet, which was invisible in Europe, and thereby first confirmed the shortness of its periodic time. He afterwards observed and discovered many other comets, some of which were not seen in Europe. He observed the sun in the solstices, made many observations with Kater’s pendulum, and determined the magnetic declination and inclination. These and other observations were published in a separate volume of the Transactions of the Royal Society for 1830. His observations of the stars of the southern hemisphere are in part contained in the ‘Brisbane Catalogue,’ and in the ‘Preliminary Catalogue of Fixed Stars in the Southern Hemisphere,’ published by himself at Hamburg in 1832. In after years, however, he was never able to find leisure for continuing the work, and the greater part of the observations remain still unpublished.

In 1829 he returned to Europe to resume his post as Principal of the School of Navigation, and to undertake the Direction of the New Observatory built by the Senate of Hamburg. He devoted himself with the most unwearied diligence to the duties of these two offices. After nights passed in observing, he made his appearance at the School of Navigation at

eight both in summer and winter, and remained there teaching for five and even seven hours, regardless of his failing health, which was unable to sustain so severe a trial.

Under his care the school attained an unexpected prosperity. It produced the most distinguished sailors of the German merchant navy, and the teachers of almost all the Schools of Navigation on the coast of the North Sea have been his pupils. The number of students, which at the time of his appointment to the school was only 60, amounted to 250 in 1857. He possessed in an unusual degree the art of teaching. By the clearness of his methods, and a singular patience and mildness which encouraged the self-respect of his pupils and gained their confidence, and especially by his power of adapting his teaching to the comprehension of each individual, he succeeded in preparing the most uncultivated sailor for the examination in navigation often in a surprisingly short time, so as to enable him to pass it with credit.

His 'Handbook of Navigation,' which appeared in 1843, and has gone through three large editions, is used as a text-book in most of the Schools of Navigation on the shores of the North Sea, in Austria, and in Russia.

He devoted himself with equal or even still greater energy to his duties in the Observatory. The principal instruments consisted of an equatorially mounted refractor of 5-feet focal length by Fraunhofer, and a meridian circle constructed by the brothers Repsold, which was mounted in 1836. The observations made with the refractor are published in Schumacher's 'Astronomische Nachrichten,' and in the Monthly Notices of the Astronomical Society. With the meridian circle he undertook the determination of the places of all the fixed stars visible through its telescope,—a work of many years' duration, the results of which he published in the years 1843–59 under the title of a Catalogue of 12,000 fixed stars, but in reality containing upwards of 15,000.

In speaking of the observations made with the refractor, at the Anniversary Meeting of the Astronomical Society in 1854, when the medal of the Society was awarded to M. Rümker, the Astronomer Royal, President of the Society, expressed himself in the following terms:—

"For a very long time M. Rümker has been known as furnishing extra-meridional observations of comets and newly discovered planets, possessing the highest degree of accuracy, and extending to times when the objects which *he* could successfully observe were lost to other astronomers furnished apparently with much more powerful means. I have myself visited the observatory and inspected the instruments which have been devoted to these observations, and I have inquired, How is it that with instruments so insignificant you have been able to see so much more than others could see who are so much better equipped? The answer was very simple. Energy, care, patience,—in these, I believe, is contained the whole secret. M. Rümker perhaps possesses in perfection the sensibility of eye and the acuteness of ear which are required for the most delicate observations; but

these powers, which might seem at first to be original gifts of nature, have, I do not doubt, acquired very much of their activity from their careful and energetic use."

Adverting to the Catalogue of fixed stars, for which more especially the medal was bestowed, Mr. Airy observes,—

"Had this Catalogue proceeded from an observatory of which the personal establishment was charged with no other labours, we should have considered it as a highly meritorious work. . . . What, then, shall we say to this work in the circumstances under which it has reached us? It has come, the voluntary enterprise of an individual, who could not, by any construction of his connexion with the *Hamburgh Observatory*, be supposed to owe to the world a hundredth part of the labour which it has cost. It is the fruit of observations made in the watches of the night, and calculations made in the leisure hours of the day, by a person who would seem, to vulgar eyes, to be engrossed to the limits of human endurance by an onerous professional office. Well may we consider it as a remarkable instance of voluntary labour, undertaken under difficult circumstances, not for public display, but as an aid to science, and skilfully and steadily directed to that purpose alone."

M. Rümker was a Member of the Royal Academies of *Münich* and *Göttingen*, the *Batavian Society* of *Rotterdam*, the Royal Astronomical and many other English and Foreign learned Societies. He was elected Foreign Member of the Royal Society in 1855.

After having laboured long and profitably, repeated attacks of illness, accompanied by an asthmatic cough which increased in severity at each relapse, forced him at length (in 1857) to rest from his labours, and to seek a milder climate for the benefit of his shattered health.

At his suggestion the care of the Navigation School was entrusted to M. Niebour, who had been his assistant for many years, and that of the Observatory to his only son, George Rümker, at that time the Astronomer of the *Durham Observatory*, and now his successor as Director of the Observatory of *Hamburg*.

He had visited and been pleased with *Lisbon* during his earlier voyages, and was induced to select that place for his retreat. There, after a residence of six years, tenderly watched over by his wife, a lady of English birth, and the discoverer of the comet VI of 1847, retaining full possession of his faculties, he died on the 21st of December 1862.

Having served in the British Navy, and received the medal given to those who shared in the battle of *Algiers*, he was followed to the grave by officers of the British fleet in the *Tagus*, and by his German friends. He lies buried in a spot chosen by himself, close to *Fielding's* grave in the cemetery of the church of *Estrella*.